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**Theory and simulation of astrophysical explosions and turbulence**

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Supernova explosions are among the most dramatic in the universe. Type II supernovae follow the core collapse of a massive star, while Type Ia supernovae are typically believed to be thermonuclear explosions of carbon-oxygen white dwarfs that have accreted enough material to initiate carbon burning. In both cases, the explosion dynamics are complicated by hydrodynamic instabilities that make spherical symmetry impossible. Much of the work that is done on hydrodynamic mixing in SNe draws, on the one hand, on the fundamental instability problems of classical Rayleigh-Taylor (RT) and steady-shock Richtmyer-Meshkov (RM), and, on the other hand, on complex (often multiphysics) computational and experimental systems. These include numerical simulations of supernovae and laser-driven laboratory experiments that invoke Euler scaling to make connections to their much larger astrophysical counterparts. In this talk, we consider what additional insight is to be gained from considering a third fundamental instability problem that is more relevant than either RT or RM in isolation and somewhat less complex than the full system. Namely, we consider an idealized blast-wave-driven problem in which a localized source drives a divergent Taylor-Sedov blast wave that in turn drives a perturbed interface between heavier and lighter gamma-law fluids. Within this context, we use numerical simulations and simplified analytic models to consider the effect of the initial perturbation spectrum in determining the late-time asymptotic state of the mixing zone, the interaction of multiple unstable interfaces relevant to core-collapse supernovae, and the proximity of the forward shock to the developing instability. Finally, we discuss how laser-driven laboratory experiments might be used to help resolve some as yet unanswered questions in supernova explosion hydrodynamics.